Scaling of biodiversity loss in global coral reef fish

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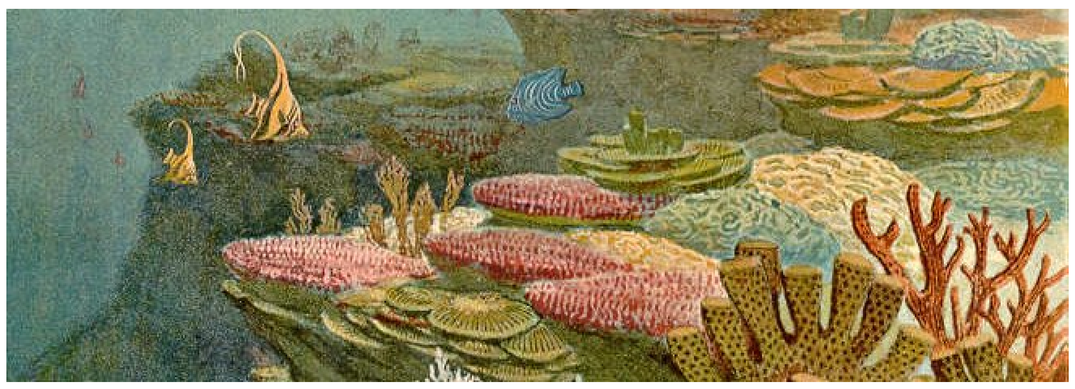
Aims

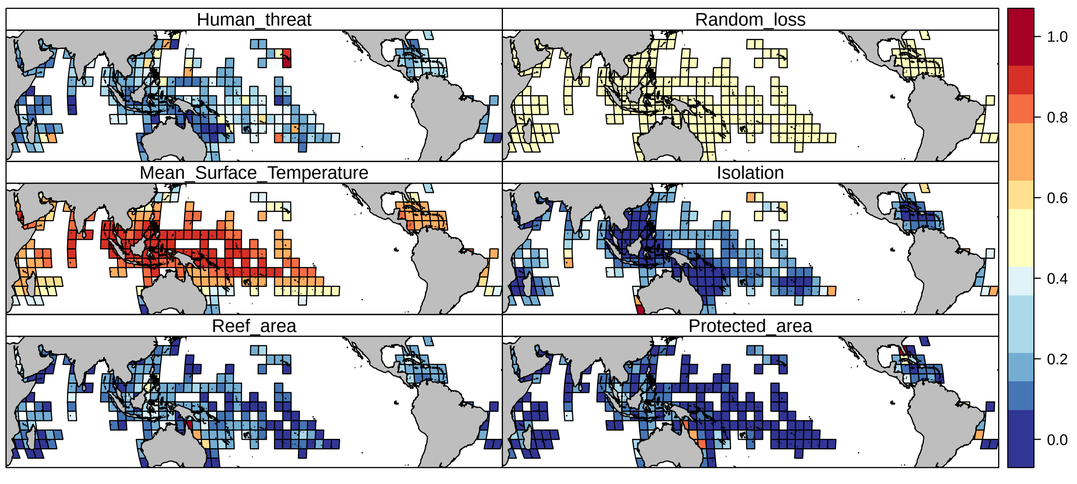
1. To predict loss of coral reef fish diversity based on **simulated scenarios of loss of coral reef area**.
2. To improve methodology of extinction estimation by moving beyond simplistic **species-area (SAR)** and **endemics-area (EAR)** relationships that ignore spatial configuration of habitat loss.
3. To base the predictions on coral reef **conservation status, area, remoteness, human pressure and climate**, and also species-specific vulnerabilities.



"Ancient coral reefs" by Heinrich Harder (1858-1935) - Wikimedia Commons

Data

- Species distributional data from the **GASPAR database** (Kulbicki *et al.* 2013, Pravicini *et al.* 2013), with 5331 species in 249 grid 5-degree cells that cover 99.76% of global coral reef area.
- Data on species-specific **vulnerability to fishing and coral bleaching** (Cheung *et al.* 2005, Graham *et al.* 2011).
- Data on five cell-specific characteristics (Paravicini *et al.* 2014):

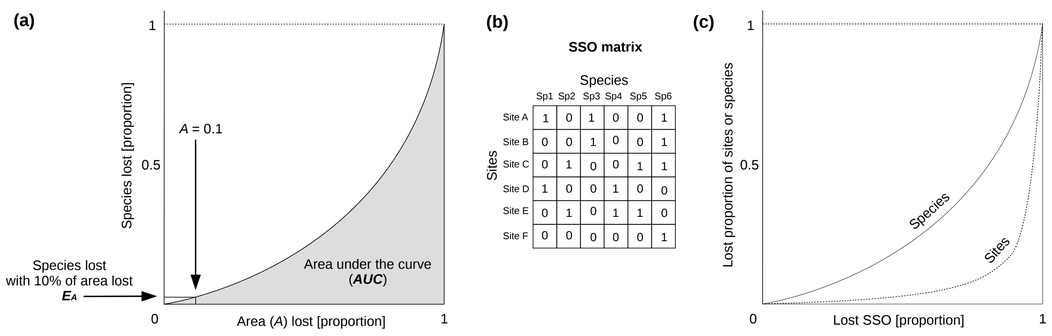


Methods

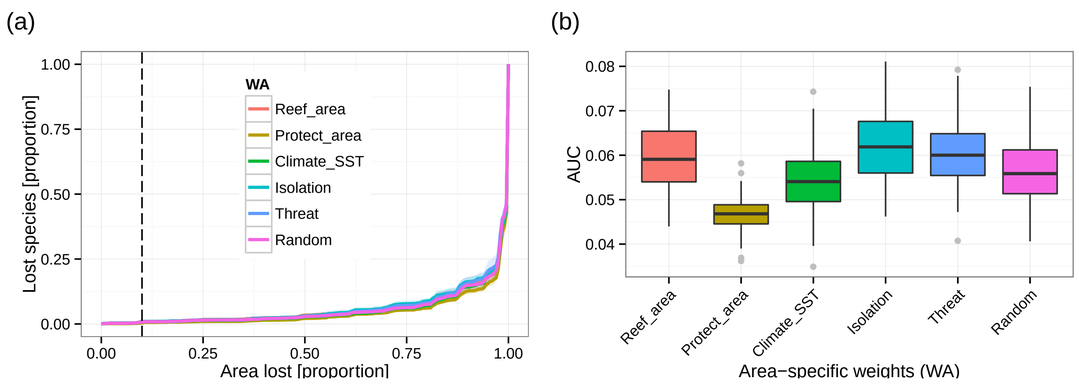
We run two distinct algorithms to simulate species loss:

1. **Site removal algorithm**. Large segments of coral reefs are completely destroyed stepwise; in each step all species living in the reef are wiped out.
2. **Removing presences in site-species occurrence (SSO) matrix**. We subsequently remove the site-specific species occurrences (SSO), which are the presences in the binary site by species matrix (panel b). The exact sequence of SSO loss depends on the properties both sites and species.

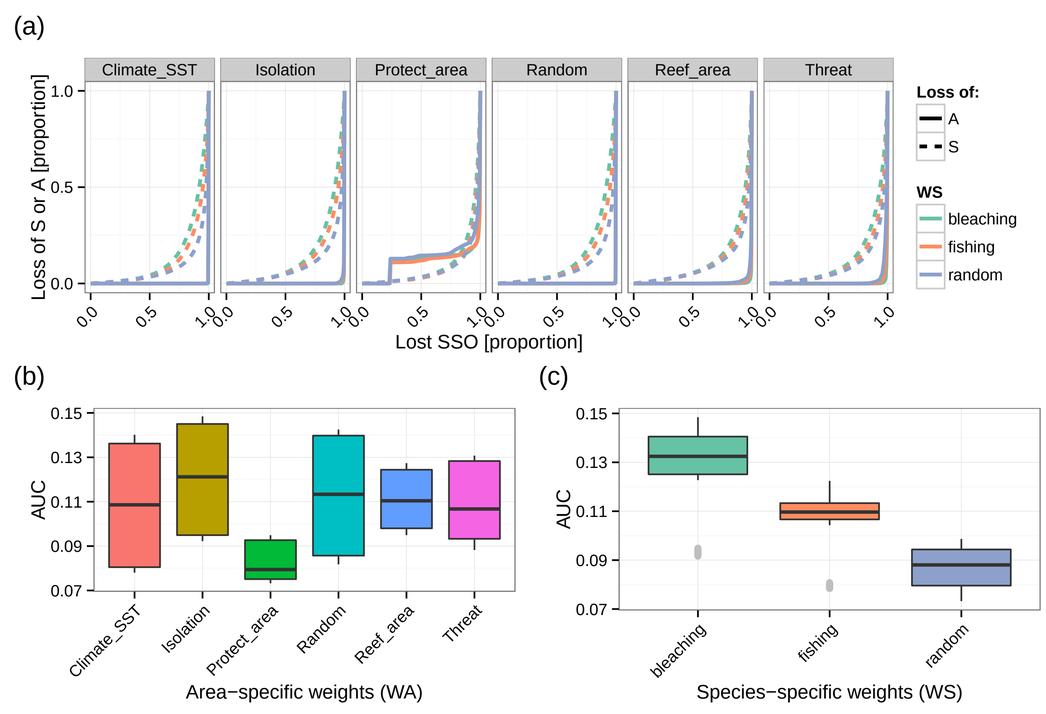
Species loss is summarized by an **extinction curve** describing relationship between area (or SSO) and number of lost species. Area under the curve (**AUC**) is our measure extinction magnitude.



Results 1: Site removal algorithm



Results 2: Removing presences in site-species occurrence (SSO) matrix



Conclusions

- Global and regional fish diversity is **surprisingly difficult to reduce** by removal of compact blocks of coral reefs.
- Area loss starting at the most **isolated** sites leads to most severe species loss.
- Area loss that initially avoids **protected areas** leads to the lowest species loss. This indicates that a non-random and unique part of reef fish diversity is covered by protected areas.
- Simulated species loss due to **fishing and coral bleaching** is higher than random loss.
- Including real-world variables into scenarios of habitat loss give different predictions than simple **SAR** models.

References

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